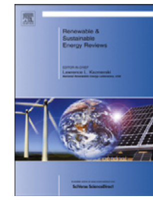
Renewable and Sustainable Energy Reviews 22 (2013) 209–222

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser



Examining the bi-directional long run relationship between renewable energy consumption and GDP growth

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A R T I C L E I N F O

Article history:
Received 7 October 2012
Received in revised form
1 February 2013
Accepted 3 February 2013
Available online 1 March 2013

Keywords:
Renewable energy consumption
GDP growth
FMOLS

A B S T R A C T

The bi-directional long run relationship between renewable energy consumption and GDP growth has been investigated in high income, upper middle income, lower middle income, and high income countries. To achieve this goal, the fully modified OLS was utilized. The results revealed that 79% of the countries have a positive bi-directional long run relationship between renewable energy consumption and GDP growth. This represents the feedback hypothesis. On the other hand, 19% of the countries showed no long run relationship between the variables. This represents the neutrality hypothesis. Besides, 2% of the countries showed a one way long run relationship from GDP growth to renewable energy consumption, confirming the conservation hypothesis, and from renewable energy consumption and GDP growth representing the growth hypothesis. Despite the mixed results across countries, it has been proved that the more persistent and significant the bi-directional long run relationship between the variables is, the higher the income countries are.

Contents

1. Introduction

The increasing concern about greenhouse gas emissions, which doubled over the last three decades, and the constant fluctuation in the price of fossil fuels encouraged many countries in the world to increase their investment on renewable energy. The renewable energy investment, industries, and policies have been rapidly increasing, especially in recent years. Based on the World Development Indicators (WDI), the renewable energy consumption increased more than 55% during the period 1980–2009. The increase in renewable energy consumption might have a huge impact on the world economic output. Despite the large amount of literature which has investigated the GDP growth–energy consumption relationship, there are only few studies that examine the relationship between renewable energy consumption and GDP growth. Moreover, most of the studies have focused on the bi-directional causal relationship between the energy consumption and GDP growth. Thus, the main goal of this study is to examine the renewable energy consumption–GDP growth relationship. In addition, unlike previous studies, this study will examine the bi-directional long run relationship

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1364-0321/$ - see front matter
http://dx.doi.org/10.1016/j.rser.2013.02.005

between renewable energy consumption and GDP growth since the sign of the long run relationship between these variables has important consequences for policy implications. More than 108 countries categorized as low income, lower middle income, upper middle income, and high income will be investigated.

The investigation of the energy consumption–GDP growth relationship has been widely covered by different studies that investigate different countries and regions using different econometrics methodologies. Tables A1–A4 review (see Appendix A) the studies that investigated the relationship between total energy consumption–GDP growth, renewable energy consumption–GDP growth, electricity consumption–GDP growth, and fossil fuel energy consumption–GDP growth respectively. This paper covered 81 studies focusing on the Granger causality test results. A number of studies revealed a bi-directional causal relationship between energy consumption (by type) and GDP growth. This relationship represents the *feedback hypothesis*. The meaning of the feedback hypothesis is that the energy consumption and GDP are jointly determined and affect each other. In addition, a one way causal relationship from energy consumption to GDP growth was found by a number of studies. This relationship represents the *growth hypothesis*, which means that energy conservation policies on energy consumption adversely affect GDP growth. Moreover, a one way causal relationship from GDP growth to energy consumption was found in a number of studies. The relationship is called the *conservation hypothesis*. Thus, energy conservation policies might implement a little or no effect on GDP growth. Finally, a number of studies found no causal relationship between energy consumption and GDP growth. This relationship represents the *neutrality hypothesis*, which means that energy conservation policies have no effect on GDP growth.

While 45% of the studies found the feedback hypothesis, 10% of the studies found the neutrality hypothesis. In addition, while the conservation hypothesis was confirmed by 25% of the studies, the growth hypothesis was confirmed by 20% of the studies.

2. Data and methodology

Two variables will be used in this study. The first is the electricity consumption from renewable sources measured in kilowatt-hour (ELR). This variable is used by Apergis and Payne [35,37–41] as an indicator of renewable energy consumption. The other variable is the gross domestic (GDP) measured in millions of constant 2000 US dollars. In addition, the time period varied across the countries is based on data availability. The data source for both variables was taken from the World Development Indicators (WDI) [83] data base. Table B1 reviews the investigated countries based on income and the data availability for each country (see Appendix B).

Prior to implementing the FMOLS, it is important to examine whether the variables are stationary, hence, the Phillips–Perron (PP) test, which is one of most common unit root test, will be used. The Phillips–Perron (PP) test uses non-parametric statistical methods to control the serial correlation in the error term. It is basically based on the following statistics:

$$t_{\alpha}^{\sim} = t_{\alpha}\left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{T(f_0-\gamma_0)(se(\hat{\alpha}))}{2f_0^{1/2}s} \quad (1)$$

where $\hat{\alpha}$ is the estimate, t_{α} is the t-ratio of α, $se(\hat{\alpha})$ is the coefficient standard error, s is the standard error, γ_0 is a consistent estimate of the error variance, and f_0 is an estimator of the residual spectrum at frequency zero.

The PP unit root test has three cases. They are: without constant and trend ($\beta_1=\beta_2=0$), with constant but no trend ($\beta_2=0$), and with constant and trend as in the test Eq. 1 above. The following null and the alternative hypotheses for each of the three cases are H_0: $\alpha=0$ (y_t is non-stationary) and H_1: $\alpha<0$ (y_t is stationary).

Since α is generally expected to be negative, the estimated τ statistic will have a negative sign. The τ test statistic ($=\hat{\alpha}/se(\hat{\alpha})$) is used to test the null hypothesis, i.e., the more negative the critical value is, the stronger the rejection of the null hypothesis in favor of the alternative hypothesis. This means there is a unit root at some chosen level of significance. Therefore, a larger negative τ value is an indication of stationarity.

Since the main goal of this study is to examine the bi-directional long run relationship between renewable energy consumption and GDP growth in low, lower middle, upper middle and high income countries, the fully modified least square (FMOLS) established by Phillips and Hansen [82] will be used. This coitnegration equation can work with variables that are stationary at different levels. It can also eliminate the long run correlation problem that exists between the cointegrating equation and stochastic regressor innovations. The FMOLS is basically unbiased and has fully efficient mixture normal asymptotics allowing for standard Wald tests using asymptotic Chi-square statistical inference. Moreover, it can work with variables that are stationary in different levels. This has an important advantage because economic time series are stationary at different levels, which may lead to produce misleading results. This problem can be controlled by the FMOLS.

The FMOLS estimator is presented as follows:

$$\hat{\theta} = \begin{bmatrix}\hat{\beta}\\ \hat{\gamma}_1\end{bmatrix} = \left(\sum_{t=1}^{T} z_t z_t'\right)^{-1}\left(\sum_{t=1}^{T} z_t y_t^{+} - T\begin{bmatrix}\hat{\lambda}_{12'}^{+}\\ 0\end{bmatrix}\right) \quad (2)$$

where Z_t is the deterministic trend and stochastic regressor, and the estimation of the FMOLS is the construction of long run covariance matrix estimators, namely $\hat{\Omega}$ and $\hat{\Lambda}$. The scalar estimator can be defined as follows:

$$\hat{\omega}_{1.2} = \hat{\omega}_{11} - \hat{\omega}_{12}\,\hat{\Omega}_{22}^{-1}\hat{\omega}_{21} \quad (3)$$

where ω is interpreted as the long run variance of the residuals. We can also apply a degree of freedom correction to $\hat{\omega}_{12}$.

3. The econometric results

The PP unit root test is utilized. Tables B2–B5 (see Appendix B) review the PP unit root test results for low income, lower middle income, upper middle income, and high income countries. The results reveal that all the variables are stationary, thus, we will proceed with the FMOLS test to examine the bi-directional long run relationship between renewable energy consumption and GDP growth. The FMOLS results are separated based on the income level. Table C1 (see Appendix C) reviews the FMOLS test results for low income countries. The results show that 11 out of 17 countries have a bi-directional positive long run relationship between renewable energy consumption and GDP growth. This indicates a long run feedback relationship which represents the feedback hypothesis. On the other hand, four of the countries, namely Congo, Democratic Republic, Ghana, Kyrgyz Republic, and Togo have no relationship between renewable energy consumption and GDP growth. This indicates the neutrality hypothesis. In addition, while a one way long run relationship from renewable energy consumption and GDP growth in Uzbekistan is found confirming the growth hypothesis, a one way long run relationship is found from GDP growth to renewable energy consumption in Zambia indicating the conservation hypothesis. However, the results for all low income countries reveal that there is a long run bi-directional long run relationship between renewable energy consumption and GDP growth, confirming the feedback hypothesis.

Table C2 reviews (see Appendix C) the FMOLS test results for lower middle income countries, showing that 23 out of 33 countries have a bi-directional long run relationship between renewable energy consumption and GDP growth indicating the feedback hypothesis. In addition, eight countries show no long run relationship between the variables, confirming the neutrality hypothesis. Moreover, a one way long run relationship from renewable energy consumption and GDP growth is found, indicating the growth hypothesis. However, the results for overall lower middle income countries reveal a bi-directional long run relationship between the variables, representing the feedback hypothesis.

The FMOLS test results for upper middle income countries in Table C3 (see Appendix C) show that 70% of the countries confirm the feedback hypothesis by the bi-directional long run relationship between renewable energy consumption and GDP growth. In addition, 29% of the countries reveal no long run relationship between the variables, representing the neutrality hypothesis, while 1% of the countries show a one way long run relationship from renewable energy consumption to GDP growth, indicating the growth hypothesis. The results for all upper middle income countries confirm the feedback hypothesis.

Table C4 (see Appendix C) shows the FMOLS results for high income countries showing that 28 out of 32 countries have a bi-directional long run relationship between renewable energy consumption and growth (feedback hypothesis). On the other hand, three of the countries, namely Croatia, Switzerland, and Trinidad and Tobago, show no long run relationship between the variables (neutrality hypothesis), while a one way long run relationship from GDP growth to renewable energy consumption is found in Italy, confirming the conservation hypothesis. In addition, the feedback hypothesis is confirmed in all high income countries.

4. Conclusion and discussion of results

The goal of this study was to examine the bi-directional long run relationship between the renewable energy consumption and GDP growth. These countries were categorized as low income, lower middle income, upper middle income and high income. To achieve the main goal of this study, the fully modified OLS test was utilized and the results were mixed across income countries. However, 79% of the countries were found to have a positive bi-directional long run relationship between renewable energy consumption and GDP growth, confirming the feedback hypothesis. However, 19% of the countries showed no long run relationship between the variables confirming the neutrality hypothesis. In addition, 2% of the countries showed a one way long run relationship from GDP growth to renewable energy consumption confirming the conservation hypothesis and from renewable energy consumption and GDP growth, representing the growth hypothesis. The results revealed that the bi-directional long run relationship between the variables is more significant the higher income the countries are. Since the renewable energy consumption plays an important role in promoting GDP growth for most of the investigated countries, it is important for these countries to increase their investments on renewable energy, because it is a clean source of energy and has less negative environmental impact. In addition, the renewable energy is important, because it increases energy security owing to the fact that countries will be less dependent on imported fossil fuels. Moreover, the Renewables Global Status Report [83] showed that during the period 2008–2011, the renewable energy projects helped to create more than 3.5 million jobs in the renewable energy industries worldwide. Thus, the increase in the investment in the renewable energy projects can help increase the level of employment.

Appendix A

Summary of the results reached by the previous studies that explored the GDP growth–energy consumption (by type); see Tables A1–A4.

Table A1
Summary of the studies on GDP growth–energy consumption relationship.

Author	Time period	Country	Methodology	Causality results	Hypothesis
Oh and Lee [1]	1970–1999	South Korea	VEC model	GDP↔ENC	Feedback hypothesis
Fallahi [2]	1960–2005	USA	MS-VAR model	GDP↔ENC 1970–2001	Feedback hypothesis
				GDP≠ENC 2002–2005	Neutrality hypothesis
Huang et al. [3]	1972–2002	Countries by income	GMM panel model	GDP≠ENC in low income	Neutrality hypothesis
				GDP→ENC positively in middle income	Conservation hypothesis
				GDP→ENC negatively in high income	Conservation hypothesis
Zhixin and Xin [4]	1980–2008	Shandong Province	Cobb –Douglas production function	GDP↔ENC	Feedback hypothesis
Balcilar et al. [5]	1990–2006	G-7 countries	Bootstrap rolling window estimation	GDP≠ENC	Neutrality hypothesis
Tsani [6]	1960–2006	Greece	Toda and Yamamoto	ENC→GDP	Growth hypothesis
				IND and RESD ↔GDP	Feedback hypothesis
Apergis and Payne [7]	1991–2005	Commonwealth of Independent States	Panel model	GDP↔ENC	Feedback hypothesis
Lee and Chang [8]	1971–2002	Asian countries	Panel model	ENC→GDP	Growth hypothesis
Apergis and Payne [9]	1980–2004	Central American countries	Panel model	ENC→GDP	Growth hypothesis
Belke et al. [10]	1981–2007	OECD countries	Panel model	GDP↔ENC	Feedback hypothesis
Mehrara [11]	1971–2002	Oil exporting countries	Panel model	GDP→ENC	Conservation hypothesis
Rufael [12]	1971–2004	African countries	VAR model	ENC→GDP in 40% of the countries	Growth hypothesis
				GDP→ENC 60% of the counties	Conservation hypothesis

Table A1 (*continued*)

Author	Time period	Country	Methodology	Causality results	Hypothesis
Soytas and Sari [13]	1950–1990	G-7 and emerging countries	VAR model	GDP↔ENC in Argentina	Feedback hypothesis
				GDP→ENC in Italy and Korea	Conservation hypothesis
				ENC→GDP in Turkey, France, Germany and Japan	Growth hypothesis
Lee [14]	1975–2001	Developing countries	Panel model	ENC→GDP	Growth hypothesis
Lise and Montfort [15]	1970–2003	Turkey	VEC Granger causality	GDP→ENC	Conservation hypothesis
Lee and Chang [16]	1965–2002	Developed countries	Panel model	GDP↔ENC in developed countries	Feedback hypothesis
	1971–2002	Developing countries		GDP→ENC in developing countries	Conservation hypothesis
Apergis and Payne [17]	1980–2005	South Africa	Panel model	ENC→GDP	Growth hypothesis
Narayan and Smyth [18]	1972–2002	G7-countries	Panel model	ENC→GDP	Growth hypothesis
Mahadevan and Adjaye [19]	1971–2002	Developed and developing countries	Panel model	GDP↔ENC in developed countries	Feedback hypothesis
				ENC→GDP	Growth hypothesis
Ozturk et al. [20]	1971–2005	Low and middle income countries	Panel model	GDP↔ENC in middle income countries	Feedback hypothesis
				GDP→ENC	Conservation hypothesis
Belloumi [21]	1971–2004	Tunisia	VAR model	GDP↔ENC	Feedback hypothesis
Akkemik and Göksal [22]	1980–2007	Developed and developing countries	Panel model	GDP↔ENC in 70% of the countries	Feedback hypothesis
				GDP≠ENC in 20% of the countries	Neutrality hypothesis
				ENC→GDP	Growth hypothesis
Al-Iriani [23]	1971–2002	GCC countries	Panel model	GDP→ENC	Conservation hypothesis
Kahsai [24]	1980–2007	SSA countries	Panel model	GDP↔ENC in all SSA and low income countries	Feedback hypothesis
				ENC→GDP	Growth hypothesis
Zhang and Xu [25]	1995–2008	China	Panel model	GDP→ENC in all China	Conservation hypothesis
				IND↔ENC in eastern China	Feedback hypothesis
Ozturk and Acaravci [26]	1980–2006	Albania, Bulgaria, Hungary and Romania	ADRL model and VEC Granger causality	GDP↔ENC in Hungary	Feedback hypothesis
				GDP≠ENC in Albania, Bulgaria, and Romania	Neutrality hypothesis
Bowden and Payne [27]	1949–2006	USA	Toda–Yamamoto	GDP↔ENC	Feedback hypothesis
				IND→ENC	Conservation hypothesis
Shuyun and Donghua [28]	1985–2007	China	Panel model	GDP↔ENC	Feedback hypothesis
Lee [29]	1971–2001	G-11 countries	VAR model	GDP↔ENC in the US	Feedback hypothesis
				ENC→GDP in Canada, Belgium, the Netherlands and Switzerland	Growth hypothesis
				GDP→ENC in France, Italy and Japan	Conservation hypothesis
Dagher and Yacoubian [30]	1980–2009	Lebanon	VAR model	GDP↔ENC	Feedback hypothesis
Mishra et al. [31]	1980–2005	Pacific Island countries	Panel model	GDP↔ENC	Feedback hypothesis

Note: ↔ indicates a bi-directional causal relationship, → indicates a one way causal relationship, and ≠ indicates no causal relationship, GDP is the gross domestic product, ENC is total energy consumption, IND is the industrial sector, and RESD is the residential sector.

Table A2
Summary of the studies on GDP growth–renewable energy consumption relationship.

Author	Time period	Country	Methodology	Causality results	Hypothesis
Menyah and Rufael [32]	1960–2007	USA	VAR model	GDP→RE	Conservation hypothesis
Menegaki [33]	19972007	Europe	Panel model	GDP≠RE	Neutrality hypothesis
Apergis et al. [34]	1984–2007	Developed and developing countries	Panel model	GDP↔RE	Feedback hypothesis
Apergis and Payne [35]	1990–2007	Emerging countries	Panel model	GDP↔RE	Feedback hypothesis
Tugcu et al. [36]	1980–2009	G-7 countries	ADRL model	GDP↔RE	Feedback hypothesis
Apergis and Payne [37]	1990–2007	Developed and developing countries	Panel model	GDP↔RE	Feedback hypothesis
Apergis and Payne [38]	1992–2007	Eurasia	Panel model	GDP↔RE	Feedback hypothesis
Apergis and Payne [39]	1985–2005	OECD	Panel model	GDP↔RE	Feedback hypothesis
Sadorsky [40]	1994–2003	Emerging countries	Panel model	GDP↔RE	Feedback hypothesis
Apergis and Payne [41]	1985–2006	Central America	Panel model	GDP↔RE	Feedback hypothesis

Note: ↔ indicates a bi-directional causal relationship, → indicates a one way causal relationship, and ≠ indicates no causal relationship, RE is the renewable energy consumption and GDP is the gross domestic product.

Table A3
Summary of the studies on GDP growth–electricity consumption relationship.

Author	Time period	Country	Methodology	Causality results	Hypothesis
Ho and Siu [42]	1966–2002	Hong Kong	Time series model	ELC→GDP	Growth hypothesis
Apergis and Payne [43]	1990–2006	88 Countries by income	Panel model	ELC↔GDP in high, upper and lower middle income	Feedback hypothesis
				ELC→GDP	Growth hypothesis
Tang [44]	1972–2003	Malaysia	ADLR	ELC↔GDP	Feedback hypothesis
Mozumder and Marathe [45]	1971–1999	Bangladesh	VAR model	GDP→ELC	Conservation hypothesis
Narayan et al. [46]	1980–2006	Seven regions	Panel model	ELC↔GDP for all regions	Feedback hypothesis
				GDP→ELC in the Middle East	Conservation hypothesis
Bildirici and Kayıkçı [47]	1990–2009	Commonwealth States	Panel model	ELC→GDP	Growth hypothesis
Kouakou [48]	1971–2008	Cote d'Ivoire	ADRL	ELC↔GDP	Feedback hypothesis
				ELC→IND	Growth hypothesis
Ciarreta and Zarraga [49]	1970–2007	Europe	Panel model	ELC→GDP	Growth hypothesis
Altinay and Karagol [50]	1950–2000	Turkey	VAR model	ELC→GDP	Growth hypothesis
Rufael [51]	1971–2001	African countries	Toda and Yamamoto	ELC↔GDP in Egypt, Gabon, and Morocco	Feedback hypothesis
				ELC→GDP in Benin, Congo and Tunisia	Growth hypothesis
				GDP→ELC in Cameroon, Senegal, Nigeria, Zambia and Zimbabwe	Conservation hypothesis
				ELC≠GDP in Algeria, Congo Rep, Kenya, South Africa, Sudan	Neutrality hypothesis
Yuan et al. [52]	1978–2004	China	VAR model	ELC→GDP	Growth hypothesis
Ouédraogo [53]	1968–2003	Burkina Faso	ADRL	ELC↔GDP	Feedback hypothesis
Shiu and Lam [54]	1971–2000	China	VAR model	ELC→GDP	Growth hypothesis
Odhiambo [55]	1971–2006	South Africa	Time series model	ELC↔GDP	Feedback hypothesis
Abosedra et al. [56]	1995–2005	Lebanon	VAR model	ELC→GDP	Growth hypothesis
Ozturk and Acaravci [57]	1971–2006	MENA	ADRL	ELC≠GDP	Neutrality hypothesis
Yoo and Kwak [58]	1975–2006	South America	Time series model	ELC→GDP in Argentina, Brazil, Chile, Columbia, and Ecuador	Growth hypothesis
				ELC↔GDP in Venezuela	Feedback hypothesis
				ELC≠GDP in Peru	Neutrality hypothesis
Ahamad and Islam [59]	1971–2008	Bangladesh	VEC model	ELC↔GDP	Feedback hypothesis
Shahbaz et al. [60]	1971–2007	Portugal	VEC model	ELC↔GDP	Feedback hypothesis
Acaravci and Ozturk [61]	1990–2006	Transition countries	Panel model	ELC≠GDP	Feedback hypothesis
Chandran et al. [62]	1971–2003	Malaysia	ADRL	ELC→GDP	Growth hypothesis
Narayan and Smyth [63]	1974–2002	Middle East	Panel model	ELC↔GDP	Feedback hypothesis
Yoo [64]	1971–2002	ASEAN	Time series model	ELC↔GDP in Malaysia and Singapore	Feedback hypothesis
				GDP→ELC in Thailand and Indonesia	Conservation hypothesis
Shahbaz and Lean [65]	1972–2009	Pakistan	Cobb–Douglas production function	ELC↔GDP	Feedback hypothesis
Narayan and Singh [66]	1971–2002	Fiji Islands	Time series model	ELC→GDP	Growth hypothesis
Shengfeng et al. [67]	1953–2009	China	Time series model	ELC→GDP	Growth hypothesis
Chen et al. [68]	1971–2001	Asian countries	Panel model	ELC↔GDP	Feedback hypothesis
Jamil and Ahmad [69]	1960–2008	Pakistan	Time series model	GDP→ELC	Conservation hypothesis

Note: ↔ indicates a bi-directional causal relationship, → indicates a one way causal relationship, and ≠ indicates no causal relationship, ELC is the total electricity consumption and GDP is the gross domestic product.

Table A4
Summary of the studies on fossil fuel energy consumption–GDP growth relationship.

Authors	Period	Country	Method	Causality results	Hypothesis
Yoo [70]	1968–2002	South Korea	VAR model	CCON↔GDP	Feedback hypothesis
Jinke et al. [71]	1980–2005	OECD and non-OECD countries	Time series model	GDP→CCON in Japan and China	Conservation hypothesis
				GDP≠CCON in India, South Korea and South Africa	Neutrality hypothesis
Rufael [72]	1965–2005	Major Coal Consuming Countries	Toda and Yamamoto non-Causality Test	CCON→GDP in India and Japan	Growth hypothesis
				GDP→CCON in China and South Korea	Conservation hypothesis
				GDP↔CCON in South Africa and the United States	Feedback hypothesis
Apergis and Payne [73]	1980–2005	OECD countries	Panel model	CCON↔GDP	Feedback hypothesis
Li and Leung [74]	1953–2007	China	Panel model	CCON↔GDP	Feedback hypothesis

Table A4 (*continued*)

Authors	Period	Country	Method	Causality results	Hypothesis
Behmiri and Manso [75]	1976–2009	OECD	Panel model	OCON↔GDP	Feedback hypothesis
Ke et al. [76]	1980–2005	Developed and developing countries	VAR model	GDP→CCON in Japan and China	Conservation hypothesis
				GDP≠CCON in India and South Africa	Neutrality hypothesis
Apergis and Payne [77]	1992–2005	67 Countries	Panel model	NCON↔GDP	Feedback hypothesis
Al-mulali [78]	1980–2009	MENA countries	Panel model	OCON↔GDP	Feedback hypothesis
				GDP↔OCON	Feedback hypothesis
				EM↔OCON	Feedback hypothesis
				EM↔OCON	Feedback hypothesis
Zou and Chau [79]	1953–2002	China	VAR model	OCON↔GDP	Feedback hypothesis
Apergis and Payne [80]	1980–2006	Emerging Countries	Panel model	CCON↔GDP	Feedback hypothesis
Kum et al. [81]	1970–2008	G-7 countries	Bootstrap-corrected causality test	NCON→GDP in Italy	Growth hypothesis
				GDP→ NCON in UK	Conservation hypothesis
				NCON↔GDP in France, Germany and United States	Feedback hypothesis

Note: ↔ indicates a bi-directional causal relationship, → indicates a one way causal relationship, and ≠ indicates no causal relationship, GDP is the gross domestic product, NCON is the natural gas energy consumption, CCON is the coal consumption, OCON is the oil consumption, and EM the CO_2 emission from energy consumption.

Table B1
Investigated countries categorized by income and the data availability for each country.

Country	Data availability	Country	Data availability	Country	Data availability
Low-income countries					
Bangladesh	1980–2009	**Zambia**	1980–2009		
Congo, Dem. Rep.	1980–2009	**Zimbabwe**	1980–2009		
Ethiopia	1980–2009				
Ghana	1980–2009				
Haiti	1990–2009				
Kenya	1980–2009				
Kyrgyz Republic	1990–2009				
Mozambique	1980–2009				
Nepal	1980–2009				
Senegal	1980–2009				
Tajikistan	1990–2009				
Tanzania	1988–2009				
Togo	1980–2009				
Uzbekistan	1990–2009				
Vietnam	1985–2009				
Lower-middle-income countries					
Albania	1984–2009	**India**	1980–2009	**Tunisia**	1980–2009
Angola	1985–2009	**Indonesia**	1980–2009	**Turkmenistan**	1980–2009
Armenia	1990–2009	**Iran, Islamic Rep.**	1980–2009	**Ukraine**	1990–2009
Azerbaijan	1990–2009	**Jordan**	1980–2009		
Bolivia	1980–2009	**Moldova**	1990–2009		
Cameroon	1980–2009	**Morocco**	1980–2009		
China	1980–2009	**Nicaragua**	1980–2009		
Congo, Rep.	1980–2009	**Nigeria**	1980–2009		
Cote d'Ivoire	1980–2009	**Pakistan**	1980–2009		
Ecuador	1980–2009	**Paraguay**	1980–2009		
Egypt, Arab Rep.	1980–2009	**Philippines**	1980–2009		
El Salvador	1980–2009	**Sri Lanka**	1980–2009		
Georgia	1990–2009	**Sudan**	1980–2009		
Guatemala	1980–2009	**Syrian Arab Republic**	1980–2009		
Honduras	1980–2009	**Thailand**			
Upper-middle-income countries					
Algeria	1980–2009	**Malaysia**	1980–2009		
Argentina	1980–2009	**Mexico**	1980–2009		
Belarus	1990–2009	**Panama**	1980–2009		
Brazil	1980–2009	**Peru**	1980–2009		
Chile	1980–2009	**Poland**	1985–2009		
Colombia	1980–2009	**Romania**	1987–2009		
Costa Rica	1980–2009	**Russian Federation**	1990–2009		
Cuba	1980–2009	**South Africa**	1980–2009		
Dominican Republic	1980–2009	**Turkey**	1980–2009		
Gabon	1980–2009	**Uruguay**	1980–2009		

Table B1 (*continued*)

Country	Data availability	Country	Data availability	Country	Data availability
Jamaica	1980–2009	**Venezuela**	1980–2009		
Kazakhstan	1990–2009				
Latvia	1990–2009				
Lebanon	1988–2009				
Macedonia, FYR	1990–2009				
High-income countries					
Australia	1980–2009	**Israel**	1980–2009	**United Kingdom**	1980–2009
Austria	1980–2009	**Italy**	1980–2009	**United States**	1980–2009
Belgium	1980–2009	**Japan**	1980–2009		
Bulgaria	1980–2009	**Korea, Rep.**	1980–2009		
Canada	1980–2009	**Luxembourg**	1980–2009		
Croatia	1990–2009	**Netherlands**	1980–2009		
Czech Republic	1990–2009	**New Zealand**	1980–2009		
Denmark	1980–2009	**Norway**	1980–2009		
Finland	1980–2009	**Portugal**	1980–2009		
France	1980–2009	**Slovak Republic**	1982–2009		
Germany	1980–2009	**Slovenia**	1990–2009		
Greece	1980–2009	**Spain**	1980–2009		
Hungary	1980–2009	**Sweden**	1980–2009		
Iceland	1980–2009	**Switzerland**	1980–2009		
Ireland	1980–2009	**Trinidad and Tobago**	1980–2009		

Table B2
Phillips–Perron test results for low-income countries.

Country	Variables	Phillips–Perron test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
Bangladesh	**LGDP**	1.166244	2.341105	4.466634[a]	4.833232[a]
	LELR	0.971199	3.623240[c]	7.949784[a]	7.861465[a]
Congo, Dem. Rep.	**LGDP**	1.960610	1.208663	5.209758[a]	5.709420[a]
	LELR	1.411467	2.799558	6.327858[a]	6.194073[a]
Ethiopia	**LGDP**	0.405135	0.933162	2.974841[b]	3.101559
	LELR	0.277185	2.877168	5.944109[a]	5.828621[a]
Ghana	**LGDP**	0.709387	0.907673	4.006639[b]	4.132281[b]
	LELR	2.463579	1.710776	5.070176[a]	4.945404[a]
Haiti	**LGDP**	1.274924	2.755247[c]	4.647660[a]	2.905363
	LELR	2.958212[c]	3.249891	4.335288[a]	4.174413[b]
Kenya	**LGDP**	0.818321	2.754566	3.954640[a]	4.096100[c]
	LELR	2.719808[c]	2.415073	4.843160[a]	4.933349[a]
Kyrgyz Republic	**LGDP**	0.308546	0.820081	2.344664	3.624503[c]
	LELR	1.963132	1.715413	3.969807[a]	4.076151[a]
Mozambique	**LGDP**	0.294653	1.439414	4.543710[a]	4.766245[a]
	LELR	0.421028	1.446891	7.535602[a]	7.299324[a]
Nepal	**LGDP**	0.947151	0.764783	5.371479[a]	5.893832[a]
	LELR	1.730588	3.683449[b]	6.114201[a]	6.364342[a]
Senegal	**LGDP**	0.107466	1.561267	4.509555[a]	4.469643[a]
	LELR	0.295824	2.223260	3.829431[a]	3.837001[b]
Tajikistan	**LGDP**	0.116274	1.131270	2.742795[c]	4.183180[b]
	LELR	1.969993	1.986443	4.660153[a]	4.569780[a]
Tanzania	**LGDP**	0.064420	2.629156	3.538080[b]	3.275945[c]
	LELR	1.916770	2.742050	4.807633[a]	4.669123[a]
Togo	**LGDP**	0.029644	2.073680	3.922949[a]	3.861915[b]
	LELR	2.665290[c]	2.629140	8.201308[a]	8.236733[a]
Uzbekistan	**LGDP**	1.311202	1.587433	1.720493	4.416852[b]
	LELR	1.940718	2.963700	7.176692[a]	7.217041[a]
Vietnam	**LGDP**	0.667501	3.450941[b]	3.290658[b]	3.403190[c]
	LELR	1.803734	1.359015	3.323654[b]	3.706415[b]
Zambia	**LGDP**	0.347908	2.227091	3.492502	3.803572[b]
	LELR	2.315879	2.164324	8.006671[a]	6.759497[a]

Table B2 (*continued*)

Country	Variables	Phillips–Perron test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
Zimbabwe	**LGDP**	1.985777	2.833395	4.561765[a]	4.306133[a]
	LELR	2.218774	2.624462	5.944004[a]	5.970183[a]
Low income countries	**LGDP**	2.911064	1.365870	2.741880[c]	3.197680
	LELR	1.143285	1.642497	4.905637[a]	4.908511[a]

[a] Denotes significance at 1%.
[b] Denotes significance at 5%.
[c] Denotes significance at 10%.

Table B3
Phillips–Perron test results for lower middle-income countries.

Country	Variables	Phillips–Perron test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
Albania	**LGDP**	0.021672	2.452084	3.976898[a]	4.253218[b]
	LELR	2.640289[c]	3.289282[b]	5.799326[a]	4.427835[a]
Angola	**LGDP**	0.815858	0.726522	3.626700[b]	2.966749
	LELR	1.290846	0.991150	4.286213[a]	4.952334[a]
Armenia	**LGDP**	1.170754	2.091726	3.306350[c]	1.837459
	LELR	1.839517	1.885492	3.242490[b]	3.138142
Azerbaijan	**LGDP**	1.313959	2.708816	3.518798[b]	1.802225
	LELR	4.217113[b]	4.151375[b]	6.244849[a]	5.780899[a]
Bolivia	**LGDP**	1.003929	1.861147	4.529202[a]	5.352817[a]
	LELR	0.405410	2.439995	6.654119[a]	6.643183[a]
Cameroon	**LGDP**	0.589144	1.418045	4.949178[a]	4.931290[a]
	LELR	2.122095	6.294485[a]	7.836035[a]	7.996590[a]
China	**LGDP**	2.556402	1.481494	3.314052[b]	3.660392[a]
	LELR	0.753671	1.156352	5.085354[a]	4.990613[a]
Congo, Rep.	**LGDP**	0.228999	1.024728	4.765653[a]	5.054027[a]
	LELR	3.433148	3.269805[c]	6.187889[a]	6.313845[a]
Cote d'Ivoire	**LGDP**	0.120918	2.658416	4.904845[a]	4.947802[a]
	LELR	3.061352[b]	4.251751[b]	3.535447[b]	3.348885[c]
Ecuador	**LGDP**	0.119818	3.072841	3.403266[b]	3.741318[a]
	LELR	2.808142	2.127506	3.479552[a]	4.419145[a]
Egypt, Arab Rep.	**LGDP**	0.540779	3.963802[b]	3.967059[a]	3.774811[a]
	LELR	1.010457	2.665870	6.388914[a]	6.304879[a]
El Salvador	**LGDP**	1.704536	1.448098	2.081740	4.481842[a]
	LELR	0.006165	3.334514[c]	7.870237[a]	7.758624[a]
Georgia	**LGDP**	0.426519	2.790983	4.551252[b]	2.004486
	LELR	2.381109	3.415063[c]	5.606767[a]	3.573180[b]
Guatemala	**LGDP**	0.692499	1.698445	4.439523[a]	4.714024[a]
	LELR	2.236715	2.678545	5.656112[a]	5.902403[a]
Honduras	**LGDP**	1.096275	0.718752	3.728732[a]	4.000980[b]
	LELR	1.651246	1.746786	4.581206[a]	4.526207[a]
India	**LGDP**	1.753497	0.525694	2.290727	5.734544[a]
	LELR	0.455079	2.243821	5.169568[a]	5.115464[a]
Indonesia	**LGDP**	0.030204	1.946647	5.425259[a]	5.586147[a]
	LELR	3.652342[c]	1.984126	4.057280[a]	5.224816[a]
Iran, Islamic Rep.	**LGDP**	0.432838	0.847757	4.319865[a]	4.375189[a]
	LELR	2.552026	2.649316	5.155131[a]	5.048103[a]
Jordan	**LGDP**	1.756508	0.224202	1.661740	3.964928[b]
	LELR	2.932589[c]	4.414936[b]	5.422144[a]	5.310830[a]
Moldova	**LGDP**	0.233564	1.382555	2.870809[c]	4.153858[b]
	LELR	1.387745	3.221722	6.367881[a]	6.186069[a]

Table B3 (*continued*)

Country	Variables	Phillips–Perron test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
Morocco	**LGDP**	0.978356	3.286619[c]	4.983288[a]	4.926413[a]
	LELR	2.126532	5.110622[a]	5.081676[a]	4.968880[a]
Nicaragua	**LGDP**	1.111451	2.616598	4.824999[a]	4.804267[a]
	LELR	1.552686	2.178356	6.313321[a]	6.215166[a]
Nigeria	**LGDP**	0.378797	2.086587	4.027548[a]	5.449999[a]
	LELR	1.497563	0.633267	5.294884[a]	5.814896[a]
Pakistan	**LGDP**	0.597930	1.374572	5.045704[a]	5.374669[a]
	LELR	1.926266	2.083013	4.783669[a]	4.954560[a]
Paraguay	**LGDP**	1.154401	3.570883[c]	3.598069[b]	3.747746[b]
	LELR	2.446061	2.951246	4.886836[a]	3.936693[b]
Philippines	**LGDP**	0.806226	2.987532	3.589702[b]	3.751560[b]
	LELR	2.553324	3.269252	4.683781[a]	4.716796[a]
Sri Lanka	**LGDP**	1.041626	4.444059[a]	4.136584[b]	4.264512[b]
	LELR	2.109658	2.524453	6.585516[a]	6.597009[a]
Sudan	**LGDP**	0.012732	0.909358	4.581374[a]	4.752276[a]
	LELR	0.714351	1.140900	2.689419[c]	2.502217
Syrian Arab Republic	**LGDP**	1.335904	0.208139	3.669314[b]	4.252529[a]
	LELR	3.169483[c]	2.783900	3.556915[b]	1.167133
Thailand	**LGDP**	1.177897	2.195349	2.971624[c]	2.931942
	LELR	0.212386	4.222880[b]	4.912255[a]	4.790067[a]
Tunisia	**LGDP**	0.944601	3.329376[b]	4.835051[a]	4.886093[a]
	LELR	2.653149	3.624422[b]	6.388021[a]	6.235508[a]
Turkmenistan	**LGDP**	1.952016	1.208303	1.207564	3.770265[b]
	LELR	1.616209	2.520299	3.794816[b]	3.886751[b]
Ukraine	**LGDP**	2.288630	1.300635	2.421763	4.616209[a]
	LELR	3.573198[b]	3.922833[b]	5.036479[a]	4.956473[a]
Lower middle income countries	**LGDP**	2.843684	0.223154	3.097998[b]	3.704523[b]
	LELR	1.248078	1.348990	4.832542[a]	4.880935[a]

[a] Denotes significance at 1%.
[b] Denotes significance at 5%.
[c] Denotes significance at 10%.

Table B4
Phillips–Perron test results for upper middle-income countries.

Country	Variables	Phillips–Perron Test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
Algeria	**LGDP**	0.237950	0.682606	4.215806[a]	4.336832[a]
	LELR	3.211752[b]	3.312708[c]	8.256078[a]	8.171883[a]
Argentina	**LGDP**	1.628487	2.120054	5.754466[a]	5.651874[a]
	LELR	1.473237	3.312388[c]	5.285984[a]	5.158931[a]
Belarus	**LGDP**	2.390737	1.014430	6.034846[a]	5.745753[a]
	LELR	3.169602	1.049322	4.321252[a]	4.589262[b]
Brazil	**LGDP**	0.571563	2.842481	3.598698[b]	3.598329[b]
	LELR	1.197706	2.448344	5.551457[a]	5.704901[a]
Chile	**LGDP**	0.337775	3.074108	4.805467[a]	2.914213[b]
	LELR	1.209045	4.271724[b]	5.272655[a]	5.196658[a]
Colombia	**LGDP**	0.705354	3.614812[b]	3.571090[c]	3.665244[b]
	LELR	1.608244	2.077113	5.444806[a]	5.604462[a]
Costa Rica	**LGDP**	0.016193	5.195673[a]	8.695431[a]	8.453773[a]
	LELR	0.598432	2.576324	7.635970[a]	7.511892[a]
Cuba	**LGDP**	0.526517	1.006500	4.100751[a]	4.338648[a]
	LELR	1.284407	3.297995[c]	6.064778[a]	6.045768[a]

Table B4 (*continued*)

Country	Variables	Phillips–Perron Test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
Dominican Republic	**LGDP**	0.167948	2.307129	6.124363[a]	6.165685[a]
	LELR	2.610180	2.646284	6.523216[a]	3.856170[b]
Gabon	**LGDP**	0.139806	2.080362	4.194086[a]	4.116963[a]
	LELR	4.709269[b]	5.856958[a]	7.083411[a]	7.457571[a]
Jamaica	**LGDP**	0.630496	2.584037	4.458788[b]	4.371149[a]
	LELR	2.860096[c]	2.708540	4.984715[a]	5.003558[a]
Kazakhstan	**LGDP**	1.246882	1.160359	1.940820	3.690814[b]
	LELR	2.773411	2.966049	3.330360[b]	3.076775[b]
Latvia	**LGDP**	1.552416	2.577911	3.465394[c]	3.724340[b]
	LELR	5.585377[a]	5.363511[a]	7.095828[a]	7.084005[a]
Lebanon	**LGDP**	0.193184	3.235948	3.382096[a]	4.040920[b]
	LELR	4.046937[a]	3.777231[b]	4.278155[b]	4.174295[a]
Macedonia, FYR	**LGDP**	0.104681	2.089703	2.977493[b]	2.958741
	LELR	2.751080	4.469265[b]	5.373354[a]	3.746388[b]
Malaysia	**LGDP**	0.238942	2.242060	4.066451[a]	3.916078[b]
	LELR	2.731677	2.950956	3.334054[a]	3.096487
Mexico	**LGDP**	0.430184	2.739681	4.705672[a]	4.728462[a]
	LELR	2.886627[c]	4.709787[b]	6.953942[a]	6.873690[a]
Panama	**LGDP**	0.739136	2.290997	3.269029[b]	3.526985[b]
	LELR	1.758787	4.228242[a]	6.401973[a]	6.474735[a]
Peru	**LGDP**	0.226984	5.262833[a]	6.759028[a]	6.954781[a]
	LELR	1.164672	3.772695[b]	7.035625[a]	6.899213[a]
Poland	**LGDP**	0.168350	2.990047	5.073308[a]	5.178119[a]
	LELR	2.327954	0.654556	0.597056	5.030022[a]
Romania	**LGDP**	1.035557	1.316236	2.187276	4.011775[a]
	LELR	3.022420[b]	3.462824[c]	6.470717[a]	3.406770[a]
Russian Federation	**LGDP**	1.543979	1.176820	2.178544	3.500469[c]
	LELR	2.797437	2.813823[c]	5.192587[a]	4.370121[a]
South Africa	**LGDP**	0.271907	2.653803	4.219951[a]	4.213137[b]
	LELR	3.716982[b]	3.883382[b]	7.247600[a]	7.116996[a]
Turkey	**LGDP**	0.018064	2.883081	5.315870[a]	5.278086[a]
	LELR	1.732605	2.394519	6.669766[a]	6.664711[a]
Uruguay	**LGDP**	1.293465	3.022717	3.344723[b]	2.987785[b]
	LELR	4.699195[a]	4.569412[a]	8.846227[a]	8.939890[a]
Venezuela	**LGDP**	0.906305	0.964004	5.234990[a]	6.383502[a]
	LELR	2.447437	2.447437	3.526866[b]	4.447747[a]
Upper middle income countries	**LGDP**	0.633175	2.799120	2.813811[c]	3.175853
	LELR	1.235864	1.813583	5.885298[a]	5.947716[a]

[a] Denotes significance at 1%.
[b] Denotes significance at 5%.
[c] Denotes significance at 10%.

Table B5
Phillips–Perron test results for high-income countries.

Country	Variables	Phillips–Perron test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
Australia	**LGDP**	0.149783	2.880320	3.880300[a]	3.847454[b]
	LELR	0.672062	3.833589[b]	6.066043[a]	5.941069[a]
Austria	**LGDP**	0.405110	1.728886	4.046680[a]	3.902825[b]
	LELR	1.475964	3.398623[c]	6.043225[a]	5.920863[a]
Belgium	**LGDP**	0.001933	2.240558	3.675944[b]	3.445108[a]
	LELR	1.874076	0.997726	4.339949[a]	6.031570[a]

Table B5 (*continued*)

Country	Variables	Phillips–Perron test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
Bulgaria	**LGDP**	0.240354	0.684857	4.790951[a]	5.272858[a]
	LELR	2.579418	2.664761	5.668387[a]	5.744274[a]
Canada	**LGDP**	0.960725	2.907342	2.428193	4.333350[b]
	LELR	2.009307	2.885644	5.950361[a]	5.970615[a]
Croatia	**LGDP**	1.420788	5.489100[a]	2.705870[c]	2.358971
	LELR	0.964580	1.429746	3.258070[b]	8.414971[a]
Czech Republic	**LGDP**	0.213249	2.432037	4.545821[a]	3.831105[b]
	LELR	1.025701	2.968573	5.868577[a]	5.715749[a]
Denmark	**LGDP**	0.346893	1.980699	4.063243[b]	3.889298[b]
	LELR	2.955855	0.279579	4.008515[a]	5.901608[a]
Finland	**LGDP**	0.688452	3.055171	3.750749[b]	3.643334[b]
	LELR	2.156225	3.585484[c]	6.786446[a]	6.689729[a]
France	**LGDP**	0.569686	1.593851	3.995827[a]	3.876787[b]
	LELR	1.980197	0.847109	3.560129[b]	4.613224[a]
Germany	**LGDP**	0.573535	3.954704[b]	3.636506[b]	3.434770[c]
	LELR	1.153783	2.790396	5.031216[a]	5.298197[a]
Greece	**LGDP**	0.573535	3.954704[b]	3.636506[b]	3.434770[c]
	LELR	1.153783	2.790396	5.031216[a]	5.298197[a]
Hungary	**LGDP**	0.567612	2.998347	2.717041[c]	2.453994
	LELR	0.866592	0.522600	3.982414[b]	4.327327[a]
Iceland	**LGDP**	0.965474	3.541458[c]	2.607148[c]	2.503227
	LELR	1.932671	0.341574	4.250431[a]	5.017249[a]
Ireland	**LGDP**	0.052469	3.022682	3.543621[b]	3.266718[c]
	LELR	2.279396	0.069575	6.539346[a]	8.217953[a]
Israel	**LGDP**	0.799874	1.425118	4.205649[b]	4.159572[b]
	LELR	1.507575	3.303380[c]	5.429992[a]	5.361996[a]
Italy	**LGDP**	0.719051	4.109829[a]	3.863424[a]	3.788849[a]
	LELR	1.251816	2.618865	5.882125[a]	6.178223[a]
Japan	**LGDP**	2.203162	1.085855	3.619134[b]	3.764975[b]
	LELR	3.944583[a]	5.089074[a]	10.28234[a]	10.16996[a]
Korea, Rep.	**LGDP**	1.770380	1.025805	3.849313[a]	4.086934[a]
	LELR	3.410811[b]	3.753553[b]	5.450245[a]	5.455538[a]
Luxembourg	**LGDP**	0.213776	4.512680[a]	3.568203[a]	3.275920[a]
	LELR	0.606570	1.798140	5.926330[a]	5.515506[a]
Netherlands	**LGDP**	0.081316	2.728337	4.256028[a]	4.001503[a]
	LELR	1.401916	11.79143[a]	7.394560[a]	7.426910[a]
New Zealand	**LGDP**	1.123687	3.709396[b]	3.164720[b]	3.073033[b]
	LELR	1.333876	3.479194[b]	9.215535[a]	9.071785[a]
Norway	**LGDP**	0.252559	2.228641	3.240593[b]	2.936628
	LELR	3.117517[a]	4.048198[a]	5.689701[a]	5.549064[a]
Portugal	**LGDP**	0.432374	1.590733	3.390090[b]	3.291827[c]
	LELR	1.432392	5.582948[a]	8.244982[a]	8.072276[a]
Slovak Republic	**LGDP**	0.062291	4.513176[a]	3.650527[b]	3.460675[b]
	LELR	1.249645	2.105985	5.084221[a]	4.985771[a]
Slovenia	**LGDP**	0.088865	2.662013	3.250049[b]	2.962028
	LELR	2.678830	3.882015[b]	3.817399[b]	3.743206[a]
Spain	**LGDP**	0.007918	4.560368[a]	3.413424[b]	3.206606[b]
	LELR	0.629820	3.779937[b]	7.031500[a]	5.585938[a]
Sweden	**LGDP**	0.600181	4.159755[b]	3.392065[b]	3.492211[b]
	LELR	3.724315[a]	4.337722[a]	7.600040[a]	7.454386[a]
Switzerland	**LGDP**	0.494755	1.648721	4.226897[a]	4.123810[a]
	LELR	3.470321[a]	3.597013[a]	6.346283[a]	6.239291[a]
Trinidad and Tobago	**LGDP**	0.209913	1.118147	3.744176[a]	4.071734[b]
	LELR	3.282252[b]	3.221467	6.539331[a]	6.421278[a]
United Kingdom	**LGDP**	0.579054	3.060567	2.620928	5.882659[a]
	LELR	1.795661	1.685099	7.142001[a]	8.046186[a]

Table B5 (*continued*)

Country	Variables	Phillips–Perron test			
		Level		First difference	
		Intercept	Intercept and trend	Intercept	Intercept and trend
United States	**LGDP**	3.238347[b]	0.104619	2.657438[c]	2.650505
	LELR	2.394404	3.093511	4.964470[a]	4.849509[a]
High income countries	**LGDP**	1.826241	3.293388[c]	2.877602	3.511687[b]
	LELR	0.069945	2.179575	6.234728[a]	6.202204[a]

[a] Denotes significance at 1%.
[b] Denotes significance at 5%.
[c] Denotes significance at 10%.

Table C1
FMOLS test results for the low-income countries.

Country	LELR→LGDP	LGDP→LELR	Relationship
Bangladesh	1.256212[c]	0.599064[c]	LELR↔LGDP
Congo, Dem. Rep.	−0.168734	−0.076451	LELR≠LGDP
Ethiopia	0.321829[c]	0.958560[c]	LELR↔LGDP
Ghana	0.715447	0.207384	LELR≠LGDP
Haiti	−0.925342[c]	−0.283652[c]	LELR↔LGDP
Kenya	1.041801[c]	0.436079[c]	LELR↔LGDP
Kyrgyz Republic	0.141729	−0.109043	LELR≠LGDP
Mozambique	0.194980[a]	3.242306[a]	LELR↔LGDP
Nepal	0.637167[c]	1.470522[c]	LELR↔LGDP
Senegal	0.443629[c]	1.605056[c]	LELR↔LGDP
Tajikistan	6.149984[c]	0.088456[c]	LELR↔LGDP
Tanzania	2.147207[b]	0.329801[b]	LELR↔LGDP
Togo	0.325145	0.606576	LELR≠LGDP
Uzbekistan	1.073712[c]	0.249473	LELR→LGDP
Vietnam	0.461696[c]	0.830932[c]	LELR↔LGDP
Zambia	1.485116	0.126090[c]	LGDP→LELR
Zimbabwe	−0.272414[c]	−1.242117[b]	LELR↔LGDP
Low income countries	0.139769[c]	1.148459[c]	LELR↔LGDP

Note: ↔ indicates a bi-directional causal relationship, → indicates a one way causal relationship, and ≠ indicates no causal relationship.
[a] Denotes significance at 1%.
[b] Denotes significance at 5%.
[c] Denotes significance 10%.

Table C2
FMOLS test results for the lower middle-income countries.

Country	LELR→LGDP	LGDP→LELR	Relationship
Albania	1.903652[c]	0.124972	LELR→LGDP
Angola	1.640342[c]	0.542334[c]	LELR↔LGDP
Armenia	−0.303457	−0.006862	LELR≠LGDP
Azerbaijan	2.514689[c]	0.136756[c]	LELR↔LGDP
Bolivia	1.234799[c]	0.722035[c]	LELR↔LGDP
Cameroon	1.019596[c]	0.653443[c]	LELR↔LGDP
China	1.510331[a]	0.655310[a]	LELR↔LGDP
Congo, Rep.	0.457517	0.214969	LELR≠LGDP
Cote d'Ivoire	0.817398[c]	0.676564[c]	LELR↔LGDP
Ecuador	0.552048[c]	0.700920[c]	LELR↔LGDP
Egypt, Arab Rep.	2.917433[c]	0.305860[c]	LELR↔LGDP
El Salvador	2.342501[b]	0.375487[b]	LELR↔LGDP
Georgia	2.815467[c]	0.106856[b]	LELR↔LGDP
Guatemala	0.585675[c]	1.074742[c]	LELR↔LGDP
Honduras	0.892767[c]	0.377385[c]	LELR↔LGDP
India	1.829803[c]	0.520993[c]	LELR↔LGDP
Indonesia	0.551272[b]	1.141041[b]	LELR↔LGDP
Iran, Islamic Rep.	0.561386[c]	0.319963	LELR→LGDP
Jordan	0.691215[c]	1.395653[c]	LELR↔LGDP
Moldova	−0.245661	−0.213980	LELR≠LGDP
Morocco	1.086057[c]	0.568278[c]	LELR↔LGDP
Nicaragua	0.357510	0.181439	LELR≠LGDP
Nigeria	0.585734	0.053511	LELR≠LGDP

Table C2 (*continued*)

Country	LELR→LGDP	LGDP→LELR	Relationship
Pakistan	1.445755[b]	0.571314[b]	LELR↔LGDP
Paraguay	0.114559[c]	2.271837[b]	LELR↔LGDP
Philippines	1.550020[c]	0.533638[c]	LELR↔LGDP
Sri Lanka	1.697865[c]	0.388005[c]	LELR↔LGDP
Sudan	1.140096[c]	0.481897[c]	LELR↔LGDP
Syrian Arab Republic	1.145820	0.087932	LELR≠LGDP
Thailand	1.266631[c]	0.619627[c]	LELR↔LGDP
Tunisia	0.912286[b]	0.610680[b]	LELR↔LGDP
Turkmenistan	−0.190247	−0.351028	LELR≠LGDP
Ukraine	−0.103904	−0.014293	LELR≠LGDP
Lower middle income countries	1.137901[a]	0.705498[a]	LELR↔LGDP

Note: ↔ indicates a bi-directional causal relationship, → indicates a one way causal relationship, and ≠ indicates no causal relationship.
[a] Denotes significance at 1%.
[b] Denotes significance at 5%.
[c] Denotes significance 10%.

Table C3
FMOLS test results for the upper middle-income countries.

Country	LELR→LGDP	LGDP→LELR	Relationship
Algeria	0.162844	0.311425	LELR≠LGDP
Argentina	1.058039[b]	0.437707[b]	LELR↔LGDP
Belarus	0.890279[a]	0.860758[a]	LELR↔LGDP
Brazil	1.748498[a]	0.530300[a]	LELR↔LGDP
Chile	1.804104[a]	0.485167[a]	LELR↔LGDP
Colombia	1.644107[a]	0.476144[a]	LELR↔LGDP
Costa Rica	1.489493[a]	0.652514[a]	LELR↔LGDP
Cuba	0.989283[a]	0.719137[a]	LELR↔LGDP
Dominican Republic	0.649660	0.225399	LELR≠LGDP
Gabon	0.951966[a]	0.311299[a]	LELR↔LGDP
Jamaica	−0.777064	−0.171757	LELR≠LGDP
Kazakhstan	1.359134	−0.002914	LELR≠LGDP
Latvia	0.879854	0.072222	LELR≠LGDP
Lebanon	0.437895	0.058988	LELR≠LGDP
Macedonia, FYR	0.868478[b]	0.380806[c]	LELR↔LGDP
Malaysia	1.210046[a]	0.493706[a]	LELR↔LGDP
Mexico	2.996612[a]	0.260818[a]	LELR↔LGDP
Panama	1.354176[a]	0.618006[a]	LELR↔LGDP
Peru	1.902350[a]	0.466427[a]	LELR↔LGDP
Poland	1.109394[a]	0.702398[a]	LELR↔LGDP
Romania	2.462609[b]	0.087589	LELR→LGDP
Russian Federation	9.177892[a]	0.037619[a]	LELR↔LGDP
South Africa	0.267979	0.368285	LELR≠LGDP
Turkey	1.497527[a]	0.502781[a]	LELR↔LGDP
Uruguay	0.450420	0.068310	LELR↔LGDP
Venezuela	0.649396[b]	0.556060[b]	LELR↔LGDP
Upper middle income countries	1.182502[a]	0.752943[a]	LELR↔LGDP

Note: ↔ indicates a bi-directional causal relationship, → indicates a one way causal relationship, and ≠ indicates no causal relationship.
[a] Denotes significance at 1%.
[b] Denotes significance at 5%.
[c] Denotes significance 10%.

Table C4
FMOLS test results for the high-income countries.

Country	LELR→LGDP	LGDP→LELR	Relationship
Australia	4.104953[a]	0.218526[a]	LELR↔LGDP
Austria	4.569521[a]	0.195882[a]	LELR↔LGDP
Belgium	0.552342[a]	1.255256[a]	LELR↔LGDP
Bulgaria	1.480617[a]	0.270366[b]	LELR↔LGDP
Canada	3.866907[a]	0.218416[a]	LELR↔LGDP
Croatia	2.068971	0.071861	LELR≠LGDP
Czech Republic	1.674770[a]	0.553097[a]	LELR↔LGDP
Denmark	0.279180[a]	3.349329[a]	LELR↔LGDP
Finland	1.796504[a]	0.465213[a]	LELR↔LGDP
France	1.117813[a]	0.896251[a]	LELR↔LGDP
Germany	0.595302[b]	0.769776[a]	LELR↔LGDP
Greece	1.260183[a]	0.509291[a]	LELR↔LGDP
Hungary	0.624578[a]	1.347146[a]	LELR↔LGDP
Iceland	1.162612[a]	0.747607[a]	LELR↔LGDP
Ireland	1.313909[a]	0.488124[a]	LELR↔LGDP
Israel	0.604038[a]	1.596873[a]	LELR↔LGDP
Italy	1.923663	0.123778[b]	LGDP→LELR
Japan	4.777530[a]	0.091640[a]	LELR↔LGDP
Korea, Rep.	2.139118[a]	0.166302[a]	LELR↔LGDP
Luxembourg	1.406863[b]	0.319626[b]	LELR↔LGDP
Netherlands	0.422542[a]	2.191660[a]	LELR↔LGDP
New Zealand	4.340116[a]	0.198029[a]	LELR↔LGDP
Norway	5.148164[a]	0.147298[a]	LELR↔LGDP
Portugal	1.888873[a]	0.283431[a]	LELR↔LGDP
Slovak Republic	1.769200[a]	0.460973[a]	LELR↔LGDP
Slovenia	3.356386[a]	0.167195[a]	LELR↔LGDP
Spain	1.552312[a]	0.380234[a]	LELR↔LGDP
Sweden	2.916504[a]	0.116764[a]	LELR↔LGDP
Switzerland	2.188939	0.038269	LELR≠LGDP
Trinidad and Tobago	−1.016282	−0.158471	LELR≠LGDP
United Kingdom	0.927781[a]	0.932103[a]	LELR↔LGDP
United States	2.744496[a]	0.177002[a]	LELR↔LGDP
High income countries	4.152089[a]	0.224263[a]	LELR↔LGDP

Note: ↔indicates a bi-directional causal relationship,→indicates a one way causal relationship, and ≠indicates no causal relationship.

[a] Denotes significance at 1%.

[b] Denotes significance at 5%.

Appendix B

The classification of the countries and the Unit Root Test Results; see Tables B1–B5

Appendix C

The fully modified OLS test results; see Tables C1–C4

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